

III. "On Radiant Matter Spectroscopy: Note on the Spectra of Erbium." By WILLIAM CROOKES, F.R.S. Received Jan. 7, 1886.

I have recently succeeded in getting the earth erbium in a sufficiently pure state to allow me to examine its phosphorescent spectrum without the interference which might be produced by the presence of yttria, samaria, holmia, thulia, $Y\alpha$ or ytterbia. As in the case of yttria* the spectrum is best seen when erbium sulphate is heated to redness and submitted to the electric discharge in a high vacuum. The addition of calcic sulphate interferes with the purity of the spectrum. In this respect erbium differs from samaria, as the latter earth seems to require the presence of some other metal to develop its phosphorescent properties.

The phosphorescent spectrum of erbium consists of four green bands, of which the following measurements have been taken:—

Scale of spectroscope.	λ	$\frac{1}{\lambda^2}$	Remarks.
9.750°	5564	3230	Approximate centre of a wide band, shading off at each side.
9.650°	5450	3367	Approximate centre of a band, narrower and somewhat fainter than the first band.
9.525°	5318	3536	Approximate centre of a narrow band, bright and moderately sharp on each side.
9.400°	5197	3702	Approximate centre of a band, similar in appearance to the first band, but brighter.

Fig. 1 shows the erbium phosphorescent spectrum drawn to the $\frac{1}{\lambda^2}$ scale.

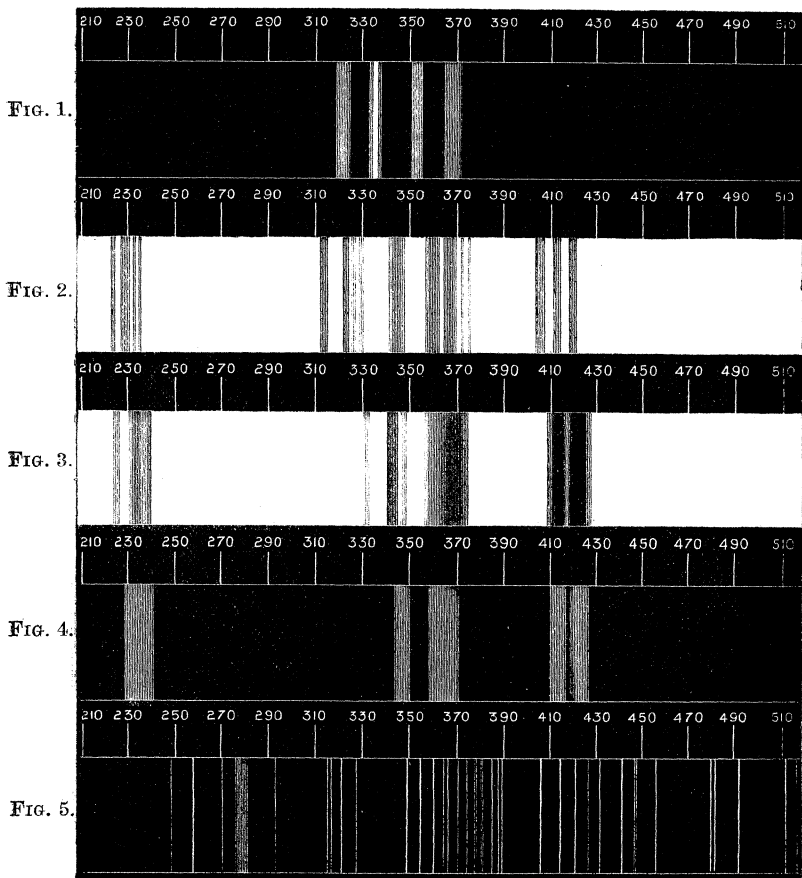
These bands do not correspond in position to any in either the yttrium or samarium spectrum. The nearest approach to a coincidence is between the first erbium green and the samarium green, but when the two spectra are examined one over the other it is seen that the samarium band is less refrangible than the erbium band.

The first green of $Y\alpha$ occurs midway between the first and second greens of erbium, and the second $Y\alpha$ green comes between the second and third erbium greens.

Pure erbium is of a beautiful rose-pink colour.† When illuminated

* "Phil. Trans.," vol. 174, p. 913, par. 71.

† Rose-coloured erbium has already been obtained by Professor Cléve, who a year ago presented me with a specimen of the earth as pure as the one which is the subject of this paper.



by sun or electric light and examined in the spectroscope it gives a spectrum of black lines and bands as sharp and distinct as the Fraunhofer lines. Fig. 2 shows the erbia spectrum by reflection. It is strange that this most characteristic property has been recorded by so few observers. Indeed, the only notice of it I have come across is a passing remark of Professor Cléve's that "the light reflected by dry erbia shows absorption-bands."

Fig. 3 shows the absorption spectrum given by a solution of pure erbic chloride. It differs in some respects from the drawings mapped from older observations, as the absorption lines of holmia and thulia are absent. The fine group of lines in the green of the reflection spectrum is also absent in the absorption spectrum.

The spectrum of bright lines emitted when erbia is rendered incandescent in the blowpipe flame has been often observed, but the

lines in this case are luminous on a fainter continuous background and are not particularly sharp, whilst the reflection spectrum consists of black lines sharply defined on a continuous spectrum.

The spectrum emitted by incandescent erbia is shown in fig. 4.

Fig. 5 shows the characteristic lines in the spark spectrum of erbium, taken from a concentrated acid solution of erbic chloride, with a Leyden jar in a shunt circuit.

I have thought it advisable to give these five spectra of erbium, as they show how entirely different the phosphorescent spectrum is to any other spectrum given by this element.

IV. "On the Clark Cell as a Standard of Electromotive Force." By the Lord RAYLEIGH, M.A., D.C.L., Sec. R.S. Received January 7, 1886.

(Abstract.)

This paper, supplementary to that "On the Electrochemical Equivalent of Silver, and on the Absolute Electromotive Force of Clark Cells,"* gives the further history of the cells there spoken of, and discusses the relative advantages of various modes of preparation. The greatest errors arise from the liquid failing to be saturated with zinc sulphate, in which case the electromotive force is too high. The opposite error of *super-saturation* is met with in certain cases, especially when the cells have been heated during or after charging. Experiments are detailed describing how cells originally supersaturated have been corrected, and how in others the electromotive force has been reduced by the occurrence of supersaturation consequent on heating. If these errors be avoided, as may easily be done; if the mercury be pure (preferably distilled *in vacuo*), and if either the paste be originally neutralised (with zinc carbonate), or a few weeks be allowed to elapse (during which the solution is supposed to neutralise itself), the electromotive force appears to be trustworthy to $\frac{1}{10000}$ part. This conclusion is founded upon the comparison of a large number of cells prepared by the author and by other physicists, including Dr. Alder Wright, Mr. M. Evans, Dr. Fleming, Professor Forbes, and Mr. Threlfall.

As regards temperature coefficient, no important variation has been discovered in saturated cells, whether prepared by the author or by others. In all cases we may take with abundant accuracy for ordinary applications—

$$E = 1.435\{1 - 0.00077(t - 15^\circ)\},$$

the temperature being reckoned in centigrade degrees. For purposes of great delicacy it is advisable to protect the standards from large

* "Phil. Trans.," vol. 175, 1884.

FIG. 1.

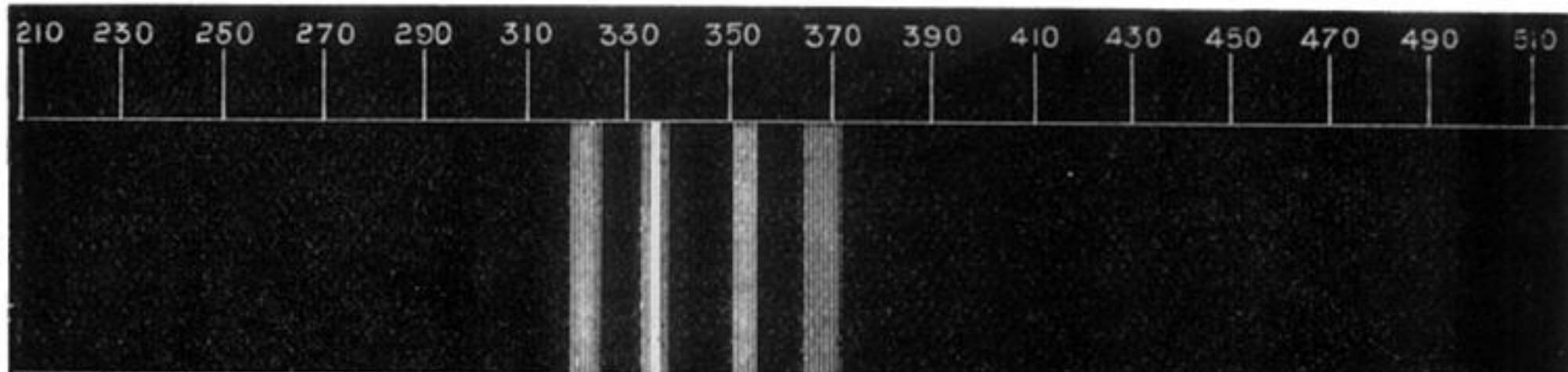


FIG. 2.

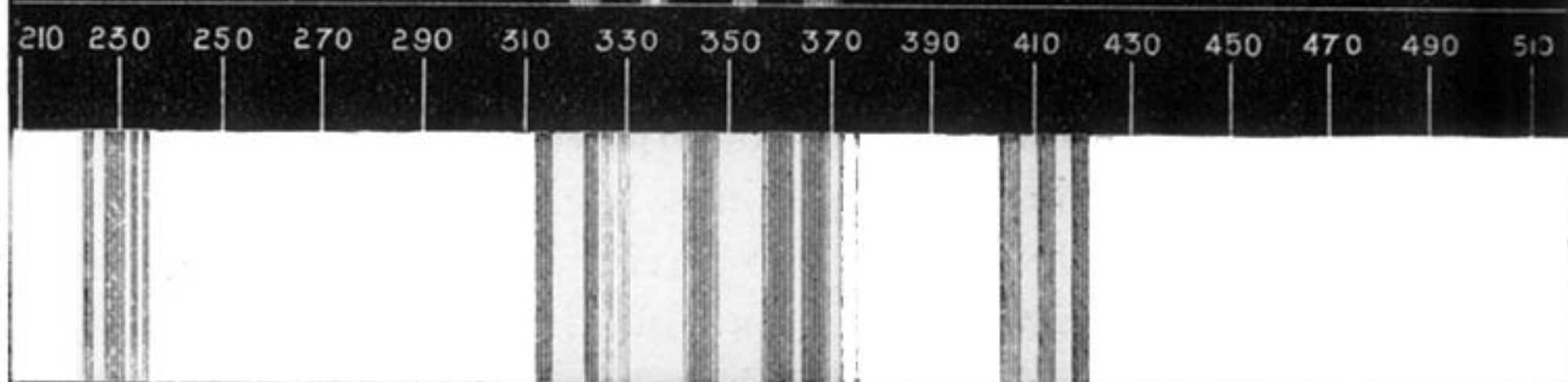


FIG. 3.

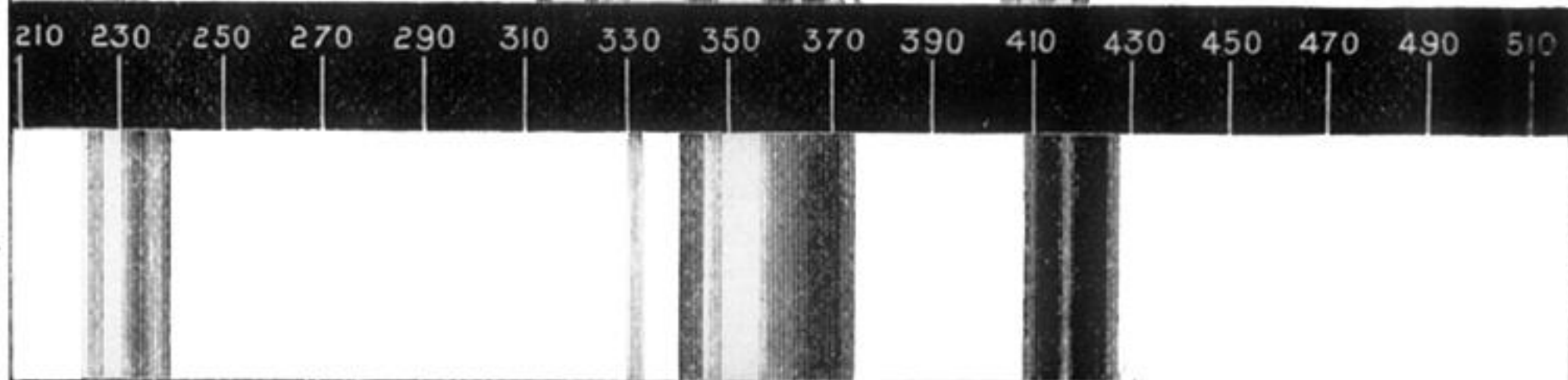


FIG. 4.

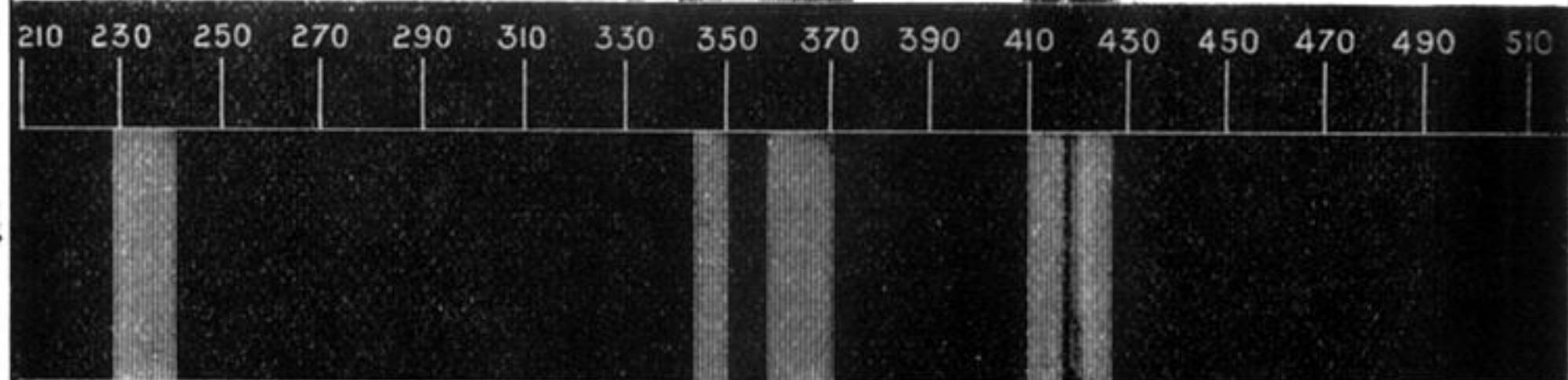


FIG. 5.

